Understanding Oceanic Heavy Precipitation using Scatterometer, Satellite Precipitation, and Reanalysis Products

Piyush Garg[1], Stephen W. Nesbitt[1], Timothy J. Lang[2], Themis Chronis[3]

[1]Department of Atmospheric Science, University of Illinois at Urbana-Champaign, Urbana, IL, USA, [2]NASA Marshall Space Flight Center, Huntsville, AL, USA, [3]University of Alabama-Huntsville, AL, USA

Introduction

The primary aim of this study is to understand the heavy precipitation events over Oceanic regions using vector wind retrievals from space based scatterometers in combination with precipitation products from satellite and model reanalyses products.

Heavy precipitation over oceans is a less understood phenomenon and this study tries to fill in the gaps which may lead us to a better understanding of heavy precipitation over oceans. Various phenomenon may lead to intense precipitation viz. MJO, Extratropical cyclones, MCSs that occur inside or outside the tropics and if we can decipher the physical mechanisms behind occurrence of heavy precipitation, then it may lead us to a better understanding of such events which further may help us in building more robust weather and climate models.

During a heavy precipitation event, scatterometer wind observations may lead us to understand the governing dynamics behind that event near the surface. We hypothesize that scatterometer winds can observe significant changes in the near-surface circulation and that there are global relationships among these quantities. To the degree to which this hypothesis fails, we will learn about the regional behavior of heavy precipitation-producing systems over the ocean. We use a "precipitation feature" (PF) approach to enable statistical analysis of a large database of raining features.

Motivation behind the Study

This study aims to address the usability of scatterometer based surface winds in studying the high impact weather events. We will try to understand the variability of surface wind characteristics in association with these extreme weather events. Following is a brief outline of the study:

- To understand a heavy precipitation regime over a certain PF
- To use a satellite based precipitation product to observe the precipitation over a grid box
- To use scatterometer based vector winds at the surface to understand the wind regime corresponding to that heavy precipitation event.
- To analyze the model based reanalysis product for surface winds
- Validating the observed wind and precipitation features over a chosen PF from a fusion of these datasets

Data and Method

In a heavy precipitation event, various parameters may be used to understand the dynamics behind it. In this study, we are trying to use the vector winds as well as the modelled reanalysis wind products to obtain a sense of wind velocity and direction over the region of study. We are using the following datasets in this study:

- Advanced Scatterometer (ASCAT-A) based vector wind products at 12.5 km horizontal resolution over a swath.
- NOAA Climate Prediction Centre (CPC) Morphing Technique (CMORPH) satellite precipitation product at 8km horizontal resolution with a temporal resolution of 30 minutes.
- MERRA daily 0.5° reanalysis product for 2m zonal and meridional winds.

First, The number of PFs were found out using CMORPH data for year 2014 and a total of 50833153 features were found for the entire year, the density of which is plotted in Fig. 1. Then for each PF, mean intensity was calculated for one month(Fig. 2). Next, ASCAT overpass was found out for the PFs and one feature(PF 111) was chosen for January, 1 2014 at 00UTC. ASCAT winds (u&v) were plotted for corresponding PF(Fig.3). Consistent to that, MERRA 2m zonal and meridional winds were plotted(Fig.4).

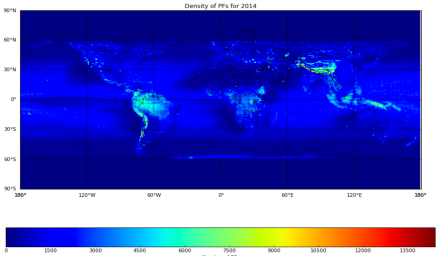


Fig.1 Number of PFs in 2014

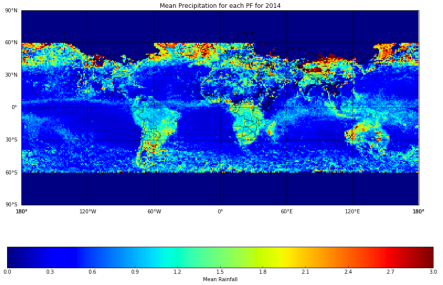


Fig.2 Mean Precipitation(mm) for January 2014

Results

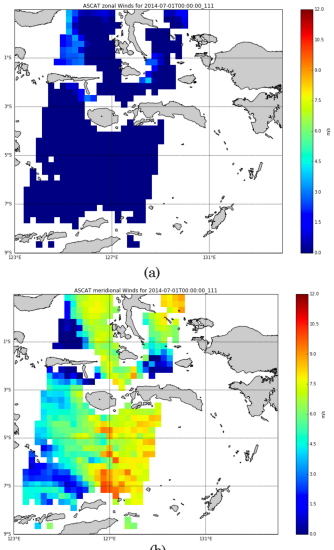


Fig. 3 ASCAT zonal(a) and meridional (b) winds for Jan 1 2014 00UTC PF 111

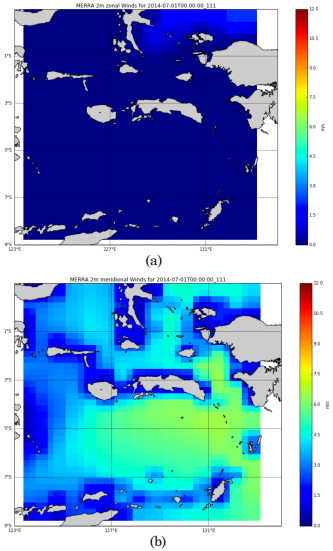


Fig. 4 MERRA zonal(a) and meridional(b) winds for Jan 1 2014 00UTC for PF 111

After analyzing the rainfall and surface wind products from a fusion of datasets, following results were drawn for this study:

- A very large number of precipitation features were observed in CMORPH dataset thus giving us an opportunity to look into different distinguishable heavy precipitation events.
- Synoptic features like Intertropical Convergence Zone(ITCZ) is clearly visible in the precipitation product of CMORPH thus this product is quite viable to use further in our study.
- Since this was the period of Austral Summer, a large amount of PFs are observed south of the equator with the position of ITCZ shifted along with it.
- Zonal wind from ASCAT shows that over the swath, wind is oriented N-S over the chosen PF while meridional wind from ASCAT shows variation in the intensity thus denoting comparatively more contribution to the concerned PF.
- Winds from MERRA reanalysis are similar to ASCAT but showing comparatively less intensity which signifies that MERRA is capturing the surface winds but underestimating the intensity over the given PF.

Conclusions

After analyzing the ASCAT winds over the chosen PF, we agree on the fact that scatterometer based vector winds is producing a good overall picture of the wind regime over oceanic regions and thus can be a good tool to analyze and study the convection features over global oceans. Also, the CMORPH product which is a high resolution rainfall product, is giving a very robust analysis of global precipitation and is quite useful for our research. MERRA based products are significant in nature and are good tools to understand the 3-D dynamical structure of the heavy precipitation events over the oceanic regions.

Future Work

This study gives overview of our approach to link between surface winds and heavy precipitation events and in future, we will be concentrating primarily on Pacific ocean to obtain better understanding of convection over Pacific Ocean to understand the cause and effect of heavy precipitation events.

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